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Accessing the Inaccessible: Demonstrators as Sources of Tacit Knowledge

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Abstract

This paper highlights a recently identified by the community perspective of design research, so far described as "inaccessible", discusses the potential of "designerly" way of approaching it in order to let designers excavate tacit knowledge from their own finished projects. We frame demonstrators as a category of design outcomes that can be a great source of such knowledge. Skills of empathy and intuition are called crucial for researchers to position themselves inside the design system looking inwards.

Keywords: research as design, demonstrator, design research, design knowledge, prototyping

1. Introduction

The fundamentals of industrial design have evolved throughout its history from the era of objects designed by individuals to complex intangible systems developed by multidisciplinary groups. The aim of design has also shifted from merely economic factors to social and ecological values, while the focus has developed from a solely professional perspective towards a participatory approach (Heskett, 2016; King and Chang, 2016; Stappers and Visser, 2007). Research, inherent in design, has expanded to explore and maintain the increased complexity of the design process.

First attempts to research in design were based on rationalistic methods. Due to their fragmented nature, they failed to grasp the artistic and human facets of design, yet developed effectively as a theoretical means of supporting design practice (Eckert *et al.*, 2003). However, this attitude has eventually led to a separation of designer and researcher (Bonsiepe, 2008) and formed a chasm between theorist and practitioner (Frost, 1999).

The scientific approach assumes that researchers keep their distance from the studied system, remaining a non-involved observer. If the focus of the research is the efficiency of the design process and the quality of the final design outcome, then it will concentrate on building knowledge and developing tools and methods to improve the design process. If the research aims to explore the nature or the history of design the result will be the understanding of its philosophy and underpinning values; structures and processes (Owen, 1998). These concepts, also known as “research FOR design” and “research ABOUT design” respectively have become fundamental modes of research in design (Findeli, 1998; Frayling, 1993; Horváth, 2007; Jonas, 2008).

Although scientific tools are powerful when the research aims to investigate the foundation of design practice in question (Verlinden and Horváth, 2007), they do not help in building design theory when practice expands into new domains. These tools have seemed to reach their limits of applicability, hence in an ambiguous field such as design, their use often leads to ungeneralizable situated knowledge. Therefore, the questions of discovering, collecting, and analyzing new information mentioned by Horvath (2008) remain unanswered.

A concept of "research THROUGH design" popularized by Frayling (1993) intends to bridge the gap between theory and practice by putting the researcher inside the studying system. In this position, design becomes a means to answer a research question. The emerging paradigm of this approach argues that the design process itself needs to guide design research instead of science, and that complexity must remain unsimplified. Nevertheless, it is still a subject of disputes whether practice constitutes research (Friedman, 2008) or it is simply a filter or a manifestation of new theories.
The fourth "dimension" of design research has recently been theorized by Glanville (1999) and later elaborated by Chow and Jonas (2008) through repositioning an observer inside the design system. In this position, design outcomes, or existing answers, are used to ask questions, erupting endless domains of research problems. It reveals a new approach in design research, "research AS design" or so-called "inaccessible research". Here the designer themselves becomes the researcher looking inwards (Figure 1).

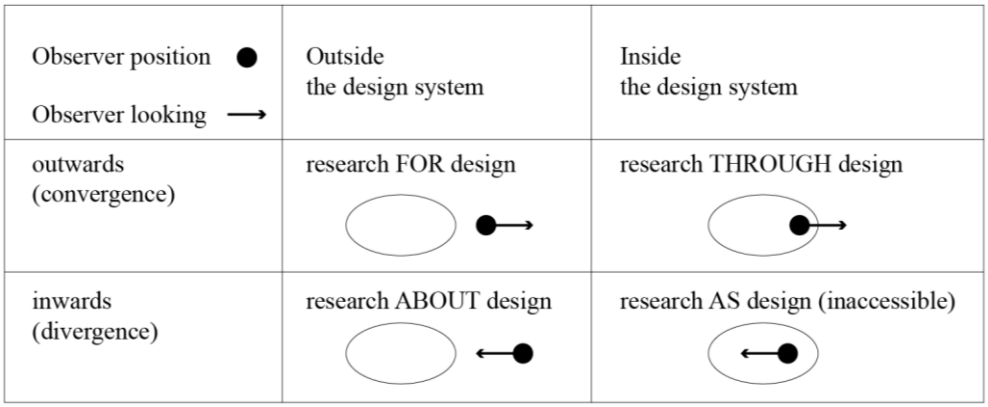

Figure 1. The concepts of research in design according to the observer position (see Chow and Jonas, 2008)

We believe that design outcomes contain more knowledge that can be discovered using the three currently most developed research modes. Polanyi's famous quote, "*We know more, than we can tell*" (1974) is perfectly applicable to design practice. There are many attempts to analyze design process and although, there has been some success in finding similarities between different disciplines, a big part of it relies on tacit knowledge, conjectures, and intuition (Darke, 1979; Dubberly, 2004; Kumar, 2009). Jonas and Grand conclude "*research in design only makes sense when all observation modes are taken into consideration*" (Grand and Jonas, 2012). Therefore, an attempt to investigate the fourth mode of research might help bridge the gap between theory and practice, approaching presently unreachable complex problems, and revealing more potential directions for design research theory.

2. Relevance

In his paper on "designerly ways of knowing", Cross notes "*the reasons advanced for developing new methods often were based on the assumption that modern, industrial design had become too complex for intuitive methods*" (2001). On the contrary, today's scientific methods still struggle to define the decision-making behind the design process. The very essence of design is that its complexity arises from dichotomies: to balance between form and function, to involve craft skills and industrial production, to facilitate client and user. The scientific approach seeks to reduce the complexity before the research in order to distill reproducible knowledge. However, not only does it lead to the opposite result but destroys the subject matter of design research (Grand and Jonas, 2012, p. 31).
Design is about practice, but this practice rests on theoretical foundations. The relationship between practice and foundations is a mutual alliance based on collective development. Design takes great inspiration from other domains, constantly expanding into new territories, bringing and incorporating new ideas and concepts. It occurs so rapidly and sometimes chaotic that the foundations cannot keep up and leave the practice without support. If design is categorized as a discipline, it possesses a lack of theoretical explanation, evoking a void between educational program, practice, and academia (Schön, 1992). In this

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paper, we propose using a specific domain of design projects, demonstrators, as starting points to build new theories in design, which will potentially merge with current theoretical foundations (Figure 2).

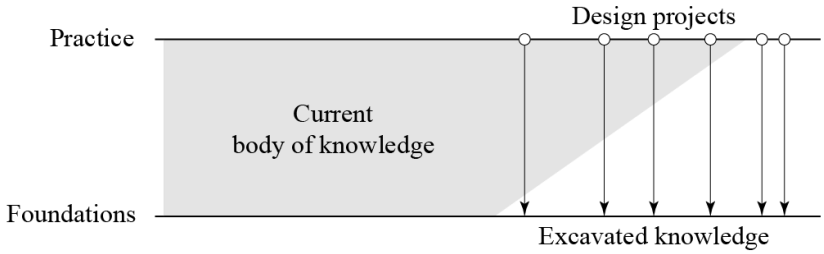

Figure 2. Reciprocity between design practice and theory (See Redström, 2017)

Since the practice far outruns the theory, as researchers we might want to change the focus from finding answers to asking questions. Hence putting ourselves inside the design system and considering a ”designerly” way of thinking as an advantage rather than a disruptive obstacle. Moreover, without the designer effectively developing intuition and empathy, it is impossible to get inside (Redström, 2017).

To embrace the spectrum of abstractness in design, Redström introduces a concept of “fluid definitions”. These definitions are formulated in a very general way but become concrete when required to address a particular subject. Such an approach helps manage the tension between a scientific focus on universal (Nelson and Stolterman, 2012) and the tendency of design to deal with the specific yet non-existent. Besides, the designers' natural “instability” is utilized to benefit the process of excavating knowledge from design outcomes, as it allows them to stay open while unfolding the design process.

In his essay, Donahue describes a seemingly routine process of opening a door with a key: “*I push the key, teeth facing up, into the lock, and it takes its ride across the tumblers, bouncing ever so slightly over each one. This particular key requires that I ease it back just a hair for it to settle in before I turn it clockwise two times, returning the latch back to its home in the lock. The door now relaxes and opens just a bit by itself*.” (2014). There is nothing more ordinary than a simple mechanical process of rotating a key in a keyhole. Yet, if we try to describe it from the perspective of a physical process such as friction, kinematics, or strength of materials, we realize that this task is of utter complexity. If we consider a movement of the hand and fingers, for example, to program this process to be performed by a robo-arm, the complexity would increase enormously. If we add a layer of the ergonomics of the key and the keyhole and take into account the way how they were produced, it will make the problem unsolvable. Yet, we have all used a key to unlock a door without any perceptible problem.

A person can keep in mind no more than five to seven elements at once before information overload (Miller, 1956). While working on a project, designers have to consider all aspects of stakeholders' opinions, ergonomic and experience factors, material and production features, aesthetics, interaction, possible emotional effects, and much more. Today, they also need to think of potential impact (Papanek, 2019), meanings (Krippendorff, 1989), and values (van de Poel, 2018) that can be featured with the design. Given that, today's design process can be compared to assembling a puzzle with extremely intricate pieces that can be put together with many combinations each of which has its pros and cons. Continuing on Dorst’s idea that designers need new strategies to handle new-found complexities (2019), we argue that design research could use benefit from the new strategies, for the same reasons. Design manipulates complex things into simple and accessible forms perceived by the general public. But designers feed more into their projects, and in fact, it makes the design system even more complex when retrospectively studied by researchers (Figure 3).

Donahue describes a project he once made with a team of students from Art Center College of Design in Pasadena. It was a full-day event, during which they constructed words about earthquakes from big boxes. After building one, it stayed for around half an hour before being destroyed and make room for the next (Figure 4). With such a simple description, designers. Their goal was to make a “conversation space”, where design works as a catalyst to initiate, facilitate and support earthquake preparedness in the community.

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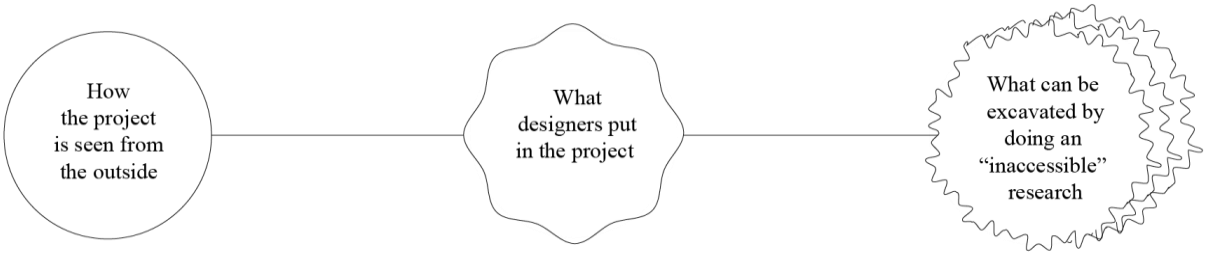

Figure 3. A project as seen by the general public (left), designers (center) and researchers (right)

Figure 4. Building (left) and discussing (right) La Has Faults Pasadena project

If we look from a distant observer's perspective, some people were just building giant letters. This obscure performance piqued the curiosity of the passers-by, encouraging adults to approach, ask questions about the project, or even participate in construction, while children would play between boxes and tunnels in letters' interiors. But if we examine from a very abstract level, we will see very complex human interactions. Including, bringing together people from different backgrounds (because curiosity attracts people regardless of their demographic), changing their perspectives (here by giving them new information about earthquakes and associated risks), creating communities (because doing something meaningful in an area causes the feeling of "ownership" and hence caring about the place) and adding value to mundane things (even without the context this activity can be considered as exercising while witnessing it brings multiple topics to discuss later with family and neighbors) (Amatullo and Donahue, 2008) (Figure 5).

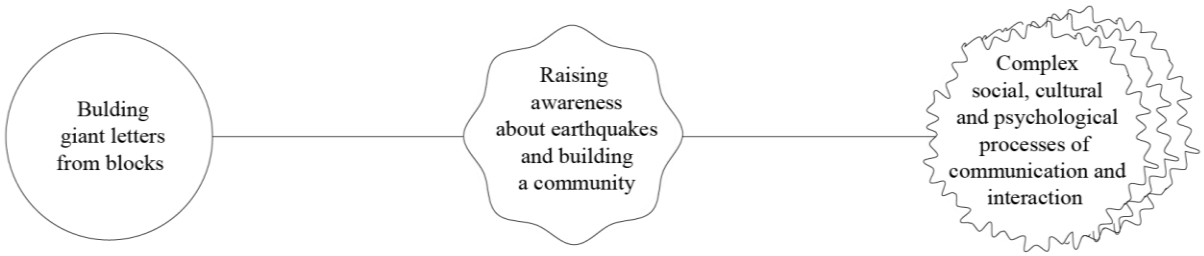

Figure 5. La Has Faults Pasadena project as seen by the general public (left), designers (center) and researchers (right)

This is just the tip of the iceberg of potential research directions. Maybe this project would elicit economical changes or societal impacts in this area if studied for a long time. Each of the possible interpretations could initiate research, enhancing the potential body of knowledge, because "the whole is always smaller than its parts" (Latour et al., 2012).

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3. Unpacking demonstrators

In the field of industrial design, there is an emerging topic called ‘demonstrators’; a versatile concept combining design, art, and engineering. It can be applied to many different innovation challenges, from decision making to creating an impact on society or specific markets. In the case of new product design, demonstrators can embody a future product or service that might be too abstract for non-experts to grasp. Their development deviates from regular product development methods, specifically in terms of the attention to the attractiveness of the design representations, iterative adaptation, and consideration of application contexts.

The purpose of demonstrators goes beyond the mere utility of regular industrial design outcomes, such as furniture or electronic devices. They are built to mediate communication between stakeholders (Smulders *et al.*, 2008), to challenge existing conceptions by amplifying the tensions and conflicts between them (Boer *et al.*, 2013), or to bring the intangible to the world of tangible (Brand, 1988). Combining features of prototypes and art pieces, demonstrators can work as manifestations and interventions. Moreover, the process of designing them demands working on a very abstract level to integrate multiple complex perspectives in a balanced output. While objects for the “research THROUGH design” approach filter the possible discussion space, focusing on a particular direction and therefore converge the research outcome. On the contrary, demonstrators, diverge it, making room for multiple interpretations. As complex systems containing significant tacit knowledge, they become perfect objects for conducting “inaccessible research”.

Elaborating on Redström’s idea of tackling the tension between the particular and the general through fluid definitions, demonstrators can be seen as physical embodiments of those. Unlike prototypes, they are finished products representing the answer to a particular question, highly depending on temporality and contextuality: in this particular time and context, the result of the design process is this particular demonstrator (Sviridova *et al.*, 2022). Theoretically, if we recreated the set of conditions including discarded potential options, the result might look completely different. Comparison with prototypes suggests itself, however, these two design outcomes do opposite tasks. Prototypes can act as both filters and manifestations (Lim *et al.*, 2008), converging the discussion space by answering the question posed, while demonstrators provoke reflection and open the discussion space.

An oscillation between general and particular, that describes a concept of reflection suggested by Schön (1984), happens during the design process and therefore is directed outwards from the design system. Also, since the reflection is ongoing, it helps adjust the future but cannot explain the past or present. Considering the inherent complexity of demonstrators, they can be perceived both from particular and general points of view. The research here will be working with the past and present, while its vector will point inwards to the design system. Thus, we argue that if demonstrators are considered from the standpoint of the fluid definition, studying them will enhance our understanding and support questioning of the relationship between problem and solution. In other words, how do we get new answers if we keep asking old questions?

The authors of this paper were involved in the creation of a demonstrator for Flanders Make, a strategic research center for the manufacturing industry to explain and promote a novel method of optimization they developed during their annual symposium. The main challenge was to explain an abstract robust optimization algorithm to people far from the fields of mathematics and computer science.

The result was a stand consisting of two parts: a physical relief based on real dimensions of the Spa Francorchamps race-track and a small cabinet in front of it hiding a projector. An animation explaining the pros and cons of using the algorithm when selecting components of a drivetrain was pre-recorded and mapped on the surface of the demonstrator (Figure 6).

When the project was complete and presented to the client, the designers reflectively analyzed the process, unpacking potential directions for further research. They noticed that using a metaphor was inevitable to express such an abstract concept as an algorithm as well as using predominantly concrete representations during the design process. Since the demonstrator was designed to be exhibited, it was possible to consider it as a medium helping stakeholders communicate and study how it enhances the communication. Using a framework of human-exhibition interaction a pilot study was conducted measuring the comprehension of the message encoded in the demonstrator (Sviridova *et al.*, 2021)(Figure 7).

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Figure 6. The process of adjusting the projection (left), the finished stand (middle) and the projected animation (right)

In other words, a project where designers encoded a metaphorical explanation of an algorithm and users watched projected animation upon closer inspection opened several complex interaction processes. These directions were discovered by the designers involved in making the demonstrator who used their informed intuition to determine prominent research directions.

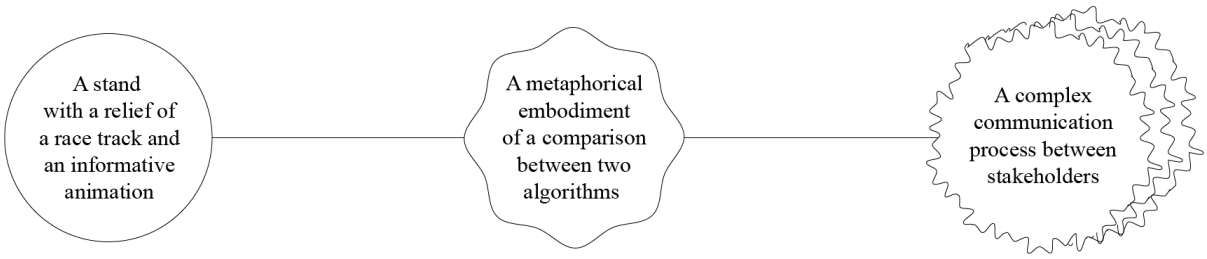

Figure 7. Flanders Make Race track project as seen by the general public (left), designers (center) and researchers (right)

4. Reaching the tacit

4.1. Inside the design system

Design research tends to separate practice from building theory on it. Which, not only increases the chasm between researcher and designer but also neglects the benefit of using skills of the latter in regards to obtaining knowledge in their discipline. We argue, that designers already have everything needed to approach the exploration of "inaccessible" research, namely, tools to put themselves inside the design system and position themselves to look inwards.

Being inside the design system means being an actor of this system, which, in the case of design, implies having different functions, playing specific roles, and being able to move between modes. It is argued that today complexity has increased not only in challenges designers face and methods they use to handle them but also in roles designers play during the design process (Meehan, 2018). There are many other stakeholders involved in the process but only designers are aware of them all and can temporarily "get into their shoes" whenever needed. Meaning, designers have trained their abilities to get inside the design system and take the role of researcher.

It is easy to confuse this location with the typical position of a researcher. However, it differs a lot from the expected analogy with the case study method, precisely because the latter is used to answer the questions (What is happening? How did it happen?) (Teegavarapu *et al.*, 2008; Yin, 2012) while the "inaccessible" approach aims to find them (What had happened? How do we analyze and explore deeper?). The research remains outside of the project aiming to collect generalizable data. The importance of this data and where to find it is defined by the research question that narrows down the

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potential search area. If the boundaries of this area are not limited, the researcher will be overloaded with the incoming data. Therefore, both of the conditions of the "inaccessible" are unreachable for research with a "scientific" approach. Designers fulfill both of them regularly. During their work, they rely highly on intuition and empathy.

Intuition is that guiding star helping the designer assemble the sophisticated pieces of a design process puzzle and overcome the increasing complexity of tasks they face. It is an ability to acquire knowledge without conscious reasoning while allowing subconscious use of this knowledge, enabling solutions, not possible through an analytical approach. Moreover, design intuition is more than a random gut feeling, it is a function based on the designer's experience, awareness of the existing and potential elements in the current situation as well as the ability to take dynamic contextual factors into account (Badke-Schaub and Eris, 2014).

Design empathy can be described as a tool that designers use to collect emotional and cognitive data of their client or user, transforming it into chunks of information that design intuition will later process (Gasparini, 2015). Furthermore, empathy helps them learn different ways to perceive the world and incorporate this experience into the design process. In case of the constantly increasing complexity of design problems, it helps designers stay flexible and receptive.

Intuition helps designers to unconsciously analyze the endless number of potential solutions, while empathy connects them with stakeholders to fuel their intuition with related information. In summary, designers are trained to use empathy and intuition quickly changing their roles and looking from the perspectives of all involved actors.

4.2. Research inside the design system

We claimed that "research AS design" is about finding questions but first, initial questions need to be asked to guide the search. In the case of this approach, the initial questions often should be addressed to the designer themselves. The methodology of which has not been developed yet but we would like to highlight several potential directions.

Many disciplines work a lot with tacit knowledge or use intuition as a primary data collection source. In sociology, there is a concept of "flow": the researcher starts when they feel it is right, continuing where they feel it should go, and stops when they feel there is nothing more to add (Markham *et al.*, 1996). In ethnography, there is a notion of "accidental ethnography", which means paying systematic attention to the unplanned daily moments (Fujii, 2014; Spanjaard, 2015).

In psychology, a technique called Internal Family Systems. is used by therapists to separate inner actors operating on a subconscious level. Guided by a professional, the procedure looks like an actual conversation happening inside the patient's head, with the patient constantly taking different parts. It is a transformative evidence-based model of psychotherapy grounded on a theory that every individual might contain several inner parts that are managed by their so-called Larger Self. Usually, Self is competent, secure, and self-assured but if there is a trauma that Self cannot manage, inner parts might intrude its guidance to protect it from the traumatic experience. From the outside, it looks like self-sabotage, excessive control, or even binge drinking. The author of the theory, Schwartz, once noticed how one of his patients seemed to fight with herself and she confirmed that she felt like there was another person inside she always needed to argue with. Then he tried to address the internal person directly, asking for their intentions and ways to reach comfort (1995).

It sounds very similar to the aforementioned theory of roles designers usually take. A possible application to design might be separating these roles in a designer's head to address them directly. It will allow designers to better understand the motives and powers behind the design project and define priorities for further research. These roles can be the project stakeholders or actors of design (e.g. analyst, producer, curator, or maker). They can even be personal characteristics of a designer, such as the inner critic or decision-maker. In any case, identifying, distinguishing, and addressing them can untangle and tackle the complexity designers and researchers deal with today.

When a role of interest is defined and separated, it can be investigated deeper by using a method of autoethnography. It is a qualitative research approach that seeks to systematically analyze personal experience in order to better understand the bigger experience of which the person is a part. This

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approach takes different forms (native, narrative, reflexive) and focuses on a deeper understanding of what matters the most for the person undertaking the study (Ellis *et al.*, 2010).

4.3. Demonstrators as fluid definitions

Demonstrators have different facets: they can be considered as an art object, a moonshot, a critical artifact, a bridge between design and engineering, and many more. Although, using a demonstrator or perceiving one often looks as easy as any other design outcome, they are designed to convey or mediate a message on multiple levels of cognition, or to connect material and dematerialized worlds (Campenhout *et al.*, 2013). In addition to many layers of comprehension provided by designers, demonstrators also are embodiments of stakeholders' positions. Lastly, they can be seen as boundary objects between different areas and disciplines (Suib, Sarah S. S. B. *et al.*, 2020), happening regardless of the designers' intentions. However, the common research conducted with such objects only applies in one dimension, when studies, e.g., the relationship between designer and maker, designer and user, or client and user.

As complex systems, demonstrators exist on different levels of abstractness, combine different mindsets and represent different disciplines. Whereas as fluid definitions they can embody all these spectrums at once and become more concrete once the space is discrete. Meaning, after we determine the research components (disciplines they connect, stakeholders' perspectives they embody, designers' roles during the design process) it will be possible to study the demonstrator from different angles. Moreover, it is plausible to narrow down the focus towards a certain aspect (specific discipline, perspective, or designer's role). As such, a single project can reveal knowledge about human-exhibition interaction, implementation of a certain technology, or ways to convert the intangible into tangible.

5. Conclusions and future work

In his essay "The Death of the Author", Roland Barthes claims that only when the process of writing is complete, can the text be untangled and open to unlimited interpretations. "*The reader is without history, biography, psychology; he is simply that someone who holds together in a single field all the traces by which the written text is constituted*" he continues (Barthes, 1977). It also means that the reader can contain all history, biography, and psychology because what matters is not what the author wanted to put in, but what the reader can discover. Same in design, only when the project is complete and the personality of the author has been removed, can the processes of untangling and acquiring knowledge begin. However, we believe that when a skilled researcher could achieve great results and conduct an excellent case study, it is a designer who can reach real depths of hidden knowledge due to their natural ability to immerse themselves within a project using intuition and empathy and study it from multiple perspectives.

This paper highlights a design research perspective recently identified by the design community, so far described as "inaccessible" and claims that a "designerly" approach based on the use of empathy and intuition can be the way to "access" it. The work of the authors manifests that demonstrators can be framed as design outcomes of high potential to conduct such research due to their complexity and innovativeness. An exemplar of an "access" tryout is presented and the plausible benefit of excavating tacit knowledge is discussed. In the currently used "research FOR/ABOUT/THROUGH design" approaches, the researcher converges the discussion space before seeking to answer a particular research question. As discussed in section 3, studying finished projects diverges such space, unveiling endless new research questions that might form new research directions. A collection of methods used by other disciplines that work closely with tacit knowledge is presented in section 4.2, among them methods of "flow", "autoethnography" and Internal Family Systems. The development of similar design research tools might provide new directions for using intuition and empathy in design research.

This paper explores the incorporation of "designerly" skills in the research of demonstrators. Having tools to excavate tacit knowledge can also be very fruitful for companies to ideate on new directions for product development. In our future work, we will discuss the development of tools and the possibility of their application in design education and the design research process.

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